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COREPHOTONICS, LTD.

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN FRANCISCO DIVISION

COREPHOTONICS, LTD.

Plaintiff,

vs.

APPLE INC.

Defendant.

Case No. 3:17-cv-06457-JD (Lead Case)
Case No. 3:18-cv-02555-JD

COREPHOTONICS, LTD.'S TECHNOLOGY SYNOPSIS

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I. INRODUCTION

Plaintiff, Corephotonics, Ltd. ("Corephotonics") submits this Technology Synopsis pursuant to the The two patents at issue in the upcoming claim construction hearing both relate to camera technology, and specifically to the miniature cameras used in mobile phones and similar devices along with the image processing technology used in such devices. Specifically, U.S. Patent 9,568,712 (the " '712 patent") relates to cellphone camera lenses and in particular to a design for a compact telephoto lens for use in such systems. U.S. Patent 9,185,291 (the " '291 patent") relates to technology for processing the images from multiple cameras used in the same device, particularly using data from multiple cameras to inter-camera differences and create a seamless and continuous user experience. These patents implicate a variety of concepts relating to camera and imaging technology discussed below.

II. CAMERA SYSTEMS GENERALLY

Cameras capture and preserve images of reality. To do this, cameras focus light through a lens on some kind of image capture medium in order to capture an image. Historically, many cameras captured images on film. Today, most cameras capture images electronically on a digital sensor. Digital cameras focus light through a lens made up of one or more glass or plastic lens elements onto the sensor. The sensor is made up of a large grid of electronic components that convert the incoming light energy into digital values representing color and intensity for each location. Each sensor location is often referred to as a pixel. The sensor transfers these digital values to a processor that can translate them into a viewable image that can be presented on a computer screen or a digital camera's view screen.

To project a high fidelity image on the sensor, a camera uses a lens. Lenses are made up of one or more individual lens elements. The various lens elements in a lens assembly are each pieces of glass or plastic with curved surfaces that bend light rays in various different ways. Individual lens elements are often disc-shaped

and the main surfaces have either a convex or concave shape. Most digital cameras also have a focus mechanism which shifts the lens in order to allow perfect focus on objects at different distances. Zoom lens can be used to magnify an object being viewed or to make the object or scene seem further away than it might to a person's eye. Such lens traditionally operate by moving groups of lens elements within the assembly.

The amount of magnification achieved by a given lens is often a function of its focal length. This refers to the distance between the front lens in the assembly and the focus plane (the plane where the image sensor is located in a digital camera, for example). A lens with a higher focal length will provide a narrower field of view with greater magnification than a lens with a lower focal length. Field of view refers to the amount of a scene which is viewed through the lens. For example, a lens with a low focal length might permit a broad field of view, showing an entire forest, while a lens with a higher focal length might permit a narrower field of view showing only one tree in that forest, but at a higher magnification that allows the viewer to resolve more details of that subject.

Another important aspect of camera lenses is their aperture. This refers to the size of the opening through which light rays can reach the image sensor. Lenses with larger apertures allow in more light rays arriving from more angles of arrival. Lenses with a larger aperture can allow cameras to produce images that are clearer even in lower light conditions. Larger aperture lenses also typically result in a shallower depth of field. This refers to the range of distances from the camera at which objects in the image are in focus. For example, in a photograph of a person standing in front of a house with a shallow depth of field (from a larger aperture lens), the person might be in focus, but the house behind them might be blurry and not in focus. With a deeper depth of field (from a smaller aperture lens), both the person and the house could be in focus at the same time. In cameras, the size of the aperture is typically referred to by something called an F number (F#) or F stop. F

number is inversely related to aperture size, meaning that a larger aperture renders a lower F number. The F# is calculated as f/A - the focal length divided by the aperture diameter. As a result, it is typical for a high magnification lens, having a high focal length, to have relatively high F#. That would mean that such lens may compromise low light performance to achieve the desired magnification. Increasing the aperture (and reducing the F#) of such lens is an important performance objective to the extent it may be achieved.

Once the light reaches the image sensor, the photons are converted into digital values of color and brightness for each location or pixel on the sensor. These values are then transferred to a processor. The camera processor main tasks are (1) to manipulate the raw sensor data in order to make the image more pleasing for human view and (2) to format the output and redirect it to camera's digital memory as image files or video files or to the camera's intrinsic display. These highly specialized processing tasks occur in a dedicated digital circuit known as the ISP – Image Signal Processor. The processor controls things like auto focus and brightness of the image. The processor would also adjust the color balance and sharpness of the image. It might also perform other kinds of processing, such as removing "noise" from the image. Noise can refer to a number of artifacts present in a digital image, but one common artifact is a grainy appearance. Such noise randomly emanates from different thermal and electrical sources. Processors can sometimes remove some of the noise caused by this kind of interference. Once the processor has processed the incoming image information from the sensor, it can generate an output image that can be displayed as a preview on the camera itself (such as on a small screen that shows a preview of the image just captured). It also can output the processed images to be saved as still images or as a video files.

III. CELL PHONE CAMERAS

Modern cell phones have increasingly become the primary cameras for most people. The compact camera modules in mobile phones are simpler, smaller, and

cheaper than digital still or video cameras. Because of the size of a mobile phone, the camera module must be in the size range of a few millimeters. The tiny size requires lenses that are dramatically smaller than those in larger digital cameras. But it is not possible to simply shrink the lenses from larger cameras to make the miniature cameras used in mobile phones. To make the tiny lens elements used in such cameras typically requires injection-molded plastic lenses, not glass as is used in many larger digital cameras. These mobile phone cameras also have a relatively small number of parts – on the order of 10 primary parts – compared to the much larger digital cameras which may have far more components. The image sensors on mobile phone cameras are also much smaller than those that can be used in larger digital cameras. For instance, some digital cameras use sensors that are similar in size to a 35mm film frame (24mmx36mm). The sensors in mobile phone cameras are typically less than 10 mm on each side. This also tends to result in much smaller and more closely packed pixels on the sensor in a mobile phone camera. For example, a mobile phone camera with a 12 megapixel (12 million individual pixels) sensor is very different from a larger digital camera with a 12 megapixel sensor. Each individual pixel in the mobile phone camera is far smaller and more closely packed together.

One of the most significant limitations on mobile phone cameras is the height of the camera – which includes the distance from the front of the lens to the image sensor. The thickness of mobile phones is one of the primary limiting factors on this dimension – the camera has to fit within a relatively thin mobile phone. This constrains many aspects of the camera, including its ability to have a focal length to create meaningful magnification with the camera lens. Another significant challenge for mobile phone cameras is the resolution of photographs that can be generated from these cameras. As noted, the cameras must be physically very small, and this requires the use of very small image sensors. This constraint limits both the number of pixels that can be used in a sensor, and also the size of the pixels that can

be used. Both of these considerations impact the quality of images generated with the cameras. Another issue with mobile phone cameras is their power consumption. The camera in a mobile phone uses the same battery power that operates all of the other functions of the device, and the more complex the processing required of the camera system, the more power it needs to consume. One more constraint on mobile phone cameras is their ability to zoom in – to magnify a subject in order to capture an image. Conventional digital cameras achieve this zoom function with physical movement of components of the camera's lens assembly to physically change the position of the various lens elements. This kind of mechanical zoom is simply not feasible in the miniature camera systems used in mobile phones.

As mobile phone cameras have attempted to address these different constraints, they have become more and more expensive. In 2012, the cost of the rear camera module for a mobile phone was in the range of $18. By the early 2020s, having 3-4 rear cameras in smartphones that total rear camera cost had increased dramatically to the range of approximately $80. One very significant area in which mobile phone cameras have improved is in their ability to zoom in on subjects and still render high-quality zoom images. Early mobile phone cameras used a single, fixed-lens camera. That camera had a fixed focal length and thus a fixed optical magnification of the image on the sensor. To achieve the appearance of zooming in on a subject, the method of digital zoom was deployed. In digital zoom the image is manipulated to appear larger while not actually increasing the amount of visible information. As an example, a small, unrecognizable license plate originally occupying 100 pixels can be zoomed by 4x, stretching it to 1600 pixels by interpolating the value of the newly generated pixels from the old ones. This will make that part of the image appear larger while actually adding no detail to help discern the numbers. This kind of digital zooming thus has limited effectiveness in practice.

Because digital zoom had severe limitations and mechanical optical zoom was not feasible given the size of mobile phone cameras, a different approach was developed to achieve the benefits of optical zoom, but within the physical limitations of mobile phone cameras. This approach involved using multiple, fixed focal length cameras together in order to create zoomed images. In a simple form, such a system might have two cameras, one with a wider field of view and relatively short focal length, and a second with a narrower, more telescoped, field of view and relatively longer focal length. The camera system could then create the effect of zooming into images by using a combination of the digital zooming techniques coupled with switching from the output of one camera to the other. Thus, for example, the system might display the image from the wider camera at first, and as the user zooms in, the system might first digitally zoom (expand the pixels) from that camera, and at some point, then begin showing the output from the other, more telescopic, lens with its higher optical magnification (and thus better rendering of details at the higher magnification). This hybrid, multi-camera approach has now become widespread in mobile phones with some using three or even more individual cameras.

Mobile phone cameras generally capture both still images and video, typically using the same cameras. They also typically have a live preview on screen of what the camera "sees" at any given moment when in use. The processing of the input from the camera sensor into either still or video images is handled by the processor based on the user's input (such as pressing a button to take a still image vs. a different button to start recording a video). To conserve power and reduce processing lag, a mobile phone might not apply the same processing to the live preview image displayed on the screen that is utilized to render a still image after a user presses the button to capture such a photo.

IV. CONCLUSION

Corephotonics anticipates that the tutorial in this matter will cover the various concepts addressed above in greater detail, as well as any questions that the Court might have.

DATED: January 27, 2023

Respectfully submitted,

RUSS AUGUST & KABAT

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CERTIFICATE OF SERVICE

I certify that counsel of record who are deemed to have consented to electronic service are being served on January 27, 2023, with a copy of this document via the Court's CM/ECF systems per Local Rule CV-5(a)(3). Any other counsel will be served by electronic mail, facsimile, overnight delivery and/or First Class Mail on this date.

/s/ Brian D. Ledahl